

### **REMARKS**

Claims 1 through 16 are pending in the captioned application. Claims 1-11, 15 and 16 stand rejected under 35 U.S.C. 103. Claims 12-14 are objected to would be allowable if rewritten in independent form. Claim 12 has been rewritten accordingly to incorporate the original limitations of claim 1 without affect from the foregoing revision, except to specify that the bridge structure comprises a layer of semiconductor material. In addition, new claim 17 has been added to preserve the subject matter of claim 12/2/1 as allowed prior to the amendment to claim 1.

#### **Rejection Of Claims 1-11, 15 and 16 Under 35 U.S.C. 103**

Claims 1-11, 15 and 16 stand rejected under 35 U.S.C. 103 as being unpatentable over U.S. Patent 4,976,200 to Benson et al in view of U.S. Patent 5,080,016 to Osher.

The Benson et al Patent discloses a tungsten bridge device including a layer of tungsten on a semiconductor bridge, for initiating energetic materials, but it does not disclose the use of titanium. The Osher Patent discloses a bridge foil device for a slapper detonator in which the bridge foil is made of a titanium hydride and it does not rest on a semiconductor bridge.

The Examiner alleges that it would have been obvious to employ the titanium bridge of the Osher Patent into the semiconductor bridge device shown by the Benson et al Patent. This allegation is respectfully traversed for the following reasons.

The device shown by the Benson et al Patent comprises a bridge of semiconductor material (silicon) on which a layer of tungsten has been deposited, so that the shape of the silicon bridge determines the width of the finished tungsten bridge (see column 3, lines 45-55). To function as an initiator, an energetic material is disposed against the tungsten bridge and a small electrical current is passed through the tungsten under a voltage of about 65 volts (see column 4, lines 63-68 and Example 3). Both the tungsten and the silicon layer beneath it vaporize and the resulting plasma initiates the energetic material (see column 5, lines 45-50 and column 4, lines 52-62).

The Osher Patent discloses a slapper initiator in which a thin layer of titanium hydride provides a bridge that is covered by a film of Mylar and then by an annular structure that provides a "gun barrel". The titanium hydride rests directly on the

"laminate surface" substrate (34); there is no bridge structure of semiconductor material beneath the titanium hydride bridge as provided beneath the tungsten in the Benson et al Patent. An electrical current generated by applying thousands of volts across the titanium hydride film (see col. 2, line 64 through col. 13, line 9 and col. 4, lines 27-29) causes the film to explode and propel a disc of the Mylar film through the gun barrel and into contact with the reactive material. It is noted that the Osher Patent discloses a comparative example which, in place of a titanium hydride, a pure titanium bridge film is used, but the Osher Patent states that the titanium hydride showed about 20% increase in the final velocity of the flyer (see column 3, lines 10-17) relative to pure titanium, thus teaching away from the use of titanium as recited in the rejected claim.

It is clear that the slapper detonator shown by the Osher Patent functions under a completely different method of operation from the initiator shown by the Benson et al Patent, that the Osher Patent device has very different energy requirements and that it requires very different structures (the gun barrel, the flyer sheet, the lack of a semiconductor bridge beneath the metal) from the Benson et al device and that the Osher Patent teaches away from the use of titanium. There is no indication in these patents that either bridge shown in the Osher Patent would function acceptably with a semiconductor bridge beneath it and without a gun barrel and flyer sheet as shown by the Benson et al Patent, and no motive is apparent in the applied references for replacing the tungsten bridge shown by the Benson et al Patent with titanium. For this reason, the Applicant respectfully traverses the allegation that it would be obvious to employ either the titanium or titanium hydride shown in the Osher Patent in the device shown by the Benson et al Patent, as alleged by the Examiner in support of the stated rejection.

To more clearly distinguish the claimed invention from the cited prior art and from the disclosure of WO 97/42462 (submitted in the Information Disclosure Statement dated May 8, 2001), which shows a layered hybrid titanium/tungsten bridge, claim 1 has been amended to define an igniter comprising a substrate having a bridge structure comprising a semiconductor material and a layer consisting essentially of titanium thereon. The term "consisting essentially of" indicates the substantial exclusion of tungsten from the metal layer since tungsten has very different properties (e.g.,

a melting temperature much higher than that of titanium and higher than the vaporization temperature of silicon) from titanium. Support for this amendment is provided by the specification because it is clear that embodiments of metal bridge layers without tungsten, have been disclosed. See, e.g., *Ex parte Parks*, 30 USPQ 2d 1234, 1236-37 (BPAI 1993) (re: claims 1-80).

For the foregoing reasons, claim 1 is patentably distinguishable over the prior art, as is new claim 18 (discussed further below).

#### New Claims 17-22

New claim 17/12 preserves the subject matter of claim 12/2/1 prior to the foregoing amendment to claim 1.

New claim 18 defines a particular embodiment of a semiconductor bridge igniter in which the bridge structure consists essentially of a layer of semiconductor material and, disposed thereon, a layer consisting essentially of titanium. The phrase "consisting essentially" in the claim transition indicates the exclusion of a gun barrel and flyer material disclosed by the Osher Patent as necessary for use with titanium and titanium hydride bridges, and the instance of "consisting essentially of" in the body of the claim to define the bridge structure indicates the substantial exclusion of tungsten as discussed above relative to claim 1.

New claims 19 and 20 further define the semiconductor material on which the titanium layer is applied in accordance with the claimed invention.

New claim 21 defines a method for initiating an energetic material achieved by a device of the kind defined in claim 1. This method is distinct from the method of operation of the Benson et al device because the Benson et al device employs tungsten as the metal on the semiconductor bridge. As discussed in the specification of the captioned application, the melting point of tungsten is approximately the same as the vaporization temperature of the semiconductor bridge material. For this reason, the tungsten absorbs so much energy from the semiconductor material beneath it that the efficiency of the device is degraded. In contrast, titanium has a melting temperature significantly lower than the vaporization temperature of the semiconductor bridge material. Therefore, as described in the application at page 3, line 18 through page 4, line 20, titanium melts well before the silicon vaporizes and the molten titanium does

not impede the plasma generated from the silicon bridge from igniting the energetic material. For this reason, by employing titanium in place of tungsten, the resulting invention provides an advantage not recognized in the cited references, i.e., the claimed device will initiate the reactive material much more reliably than prior art devices. It will be understood by one of ordinary skill in the art, upon a reading and understanding of the captioned application, that this advantage could be realized by employing any metal having a melting temperature well below the vaporization temperature of the semiconductor material. For this reason, claims 21, 22 and 23 need not be limited to titanium.

New dependent claim 22 adds further detail to claim 21, specifically defining a procedure which makes use of the relative melting and vaporizing temperatures of titanium and a typical semiconductor material such as silicon.

New dependent claim 23 specifies the use of a metal that is reactive with oxygen to provide the advantage described in the application at page 4, lines 21-28, i.e., that the reaction with oxygen contributes thermal energy towards vaporizing the semiconductor bridge and so reduces the energy requirement for the electrical firing signal. It would be understood by one of ordinary skill in the art, upon a reading and understanding of the captioned application, that this benefit can be attained by the use of oxygen-reactive metals other than titanium.

The stated rejection has been traversed by the foregoing amendments and remarks. Re-examination of the application is respectfully requested.

Respectfully submitted,

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COPY OF CLAIMS SHOWING AMENDMENTS

(Added material is underlined, deleted material is bracketed.)

1. (amended) A semiconductor bridge igniter comprising:

a substrate;

an electrical bridge structure disposed on the substrate and electrically insulated therefrom, the bridge structure comprising a layer of a semiconductor material having a negative coefficient of electrical conductivity at temperatures above ambient temperature and having disposed thereover a layer consisting essentially of titanium, the bridge structure comprising a bridge section extending between and connecting spaced-apart pad sections, each pad section being of larger area than the bridge section; and

a pair of electrically conductive lands each overlying a respective one of the pad sections and being spaced apart from each other to leave the bridge section exposed.

12. (amended) [The semiconductor bridge igniter of claim 1, claim 2 or claim 3] A semiconductor bridge igniter comprising:

a substrate;

an electrical bridge structure disposed on the substrate and electrically insulated therefrom, the bridge structure comprising a layer of a semiconductor material having a negative coefficient of electrical conductivity at temperatures above ambient temperature and having disposed thereover a layer of titanium, the bridge structure comprising a bridge section extending between and connecting spaced-apart pad sections, each pad section being of larger area than the bridge section; and

a pair of electrically conductive lands each overlying a respective one of the pad sections and being spaced apart from each other to leave the bridge section exposed, made by a method which includes preconditioning the titanium semiconductor bridge igniter by heating it to an elevated temperature to stabilize it against temperature-induced variations in bridge electrical resistance.